

SERVICE MANUAL
MODEL PLUS 4 COMPUTER
OCT. 1984 PN-314001-04

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PLUS 4 PRODUCT SPECIFICATION

MEMORY

64K RAM. 60K RAM User accessible for BASIC programs.

ROM

32K ROM Standard (includes operating system and BASIC interpreter) with 32K additional ROM containing the built-in productivity software.

MICROPROCESSOR

7501 Microprocessor — .89 or 1.76 MHz clock.

DISPLAY

40 Columns x 25 lines of text.

COLORS

128 Colors (16 colors; 8 luminance levels).

CHARACTERS

Upper & lower case letters, numerals and symbols. Reverse and flashing characters. All PET graphic characters.

DISPLAY MODES

Text characters. High resolution graphics. Split screen text/high resolution graphics. Multicolor graphics.

RESOLUTION

320 x 200 Pixels

SOUND

2 Tone generators or 1 Tone and 1 white noise generator.

VOLUME

8 Volume levels

KEYBOARD

Full size typewriter style design

KEYS

67 Keys total. 4 Cursor control keys. 4 Programmed (reprogrammable) function keys (up to 8 user defined functions possible). Color control keys. HELP key. Upper and lower case character set. Graphics character set.

INPUTS/OUTPUTS

PLUS/4 MODEM (User) port. Serial port. ROM cartridge and parallel disk drive port. 2 Joystick ports. C1531 Cassette drive interface port. RF Output-channel 3 or 4. Video output-composite/chrominance/luminance. Audio input/output. Power supply input.

PLUS 4 PRODUCT SPECIFICATION (Continued)

FEATURES

Built-in extended BASIC 3.5 — over 75 commands. Built-in Machine Language monitor — over 12 commands. Built-in graphics and sound commands. Screen window capability. Reset button (Warm start). Built-in integrated productivity software.

PERIPHERALS

C1551 Fast Disk drive, C1531 Datasette, MPS 802 Dot matrix printer, MPS 803 Dot matrix printer, DPS 1101 Daisy wheel printer, C1802 color monitor.

OTHER PERIPHERALS

C1541 Disk drive, MPS 801 Dot matrix printer, C1702 color monitor.

PLUS 4 OVERVIEW

The Plus 4 system is based on the 7501 microprocessor, an HMOS version of the 6510. Video processing is achieved by the 7360 TED chip. 64K bytes of dynamic RAM are accomplished by 8 (64K x 1) I.C.'s. (See page). The system program is contained in 2 (16K x 8) ROMs. The system supports up to 128K x 8 of ROM banked in 16K sections. By software control, through the 7360, ROM can be completely banked out and RAM banked in for a true 64K of RAM (minus 256 byte pages), allowing 60,671 bytes available for BASIC.

Keyboard and joystick scanning are accomplished by outputting the row data on the data bus while addressing a particular register in the TED chip. This will in turn cause the TED chip to latch the column information.

A standard serial port supports serial bus peripherals such as the 1541 disk drive and the various serial printers. A cassette port is provided and the expansion port supports ROM cartridges. TTL serial ASCII is intended to drive an RS-232 adapter.

PARTS LIST PLUS/4

TOP CASE ASSY

Top Case	C 251453-01
Keyboard, 67 Key, KKR-I	C 251501-01
Nameplate	C 251655-01
Shield Clip, R	C 251855-01
Shield Clip, F	C 251856-01

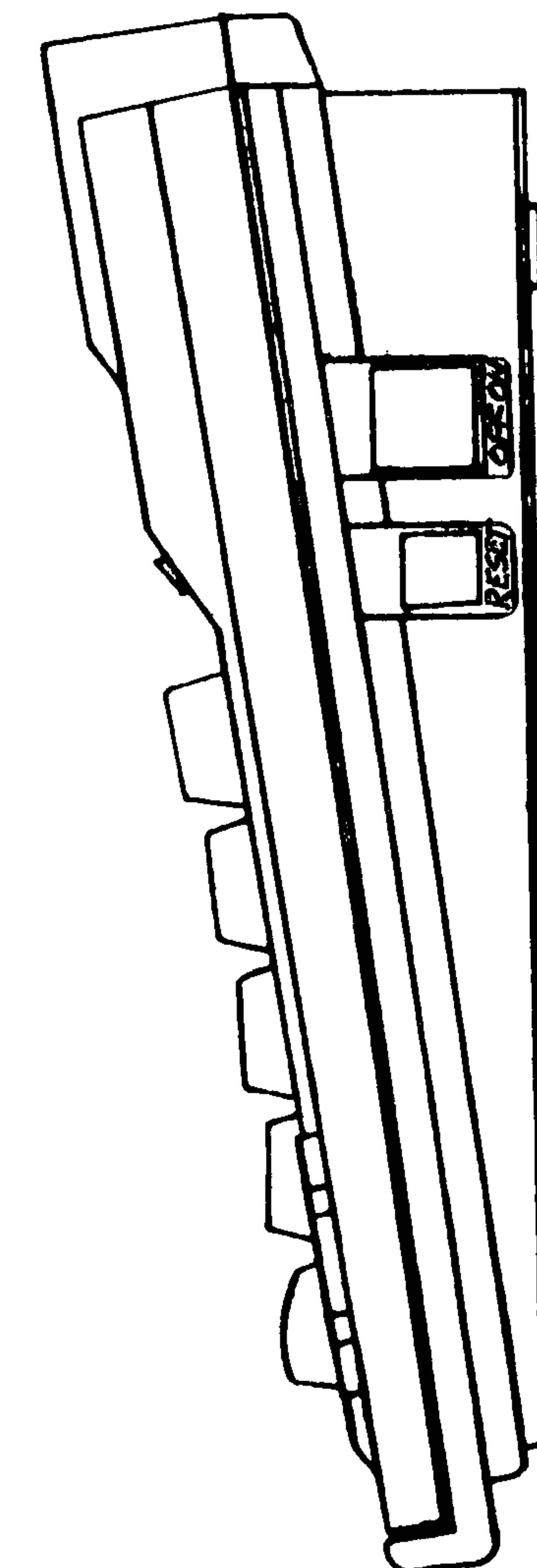
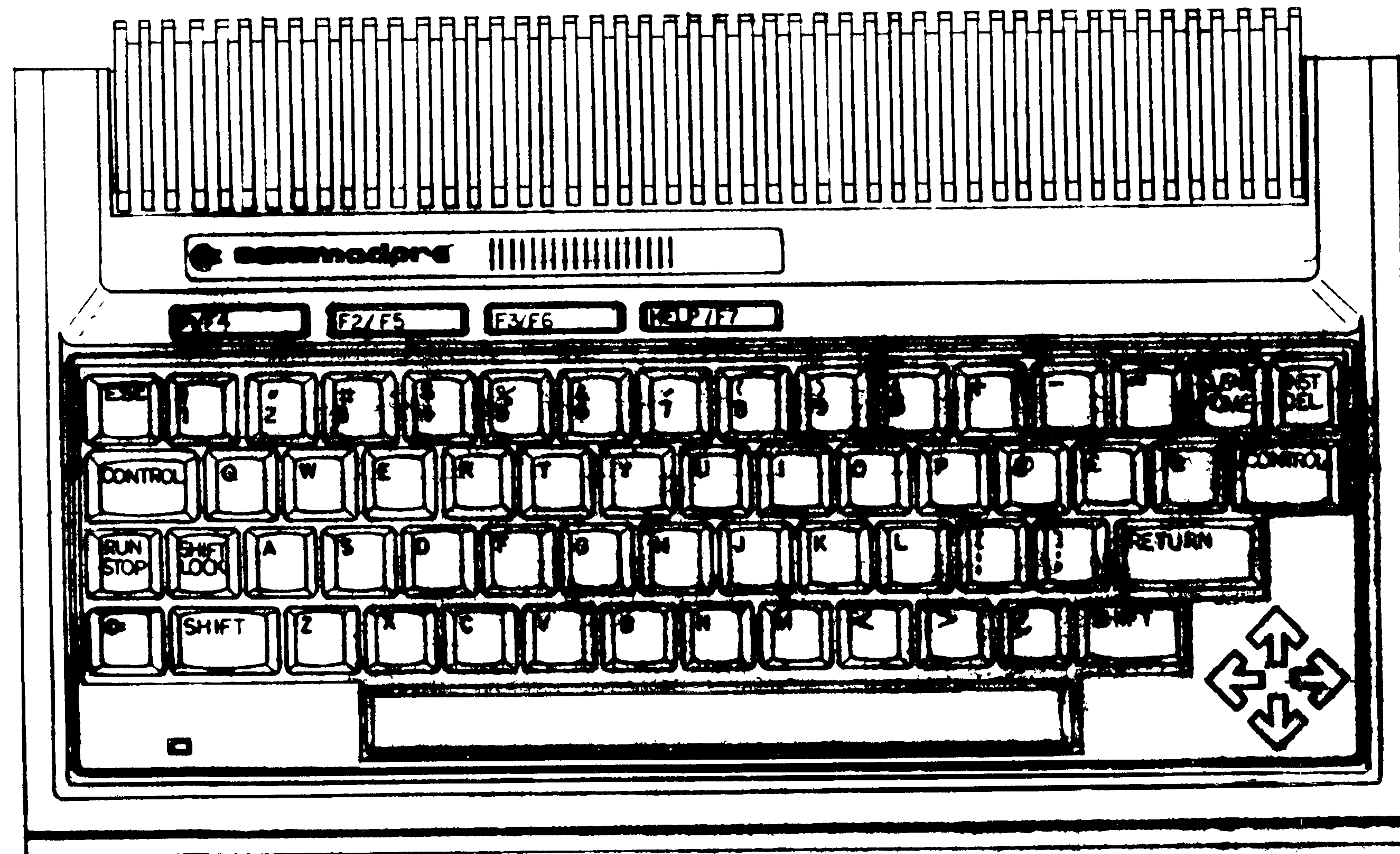
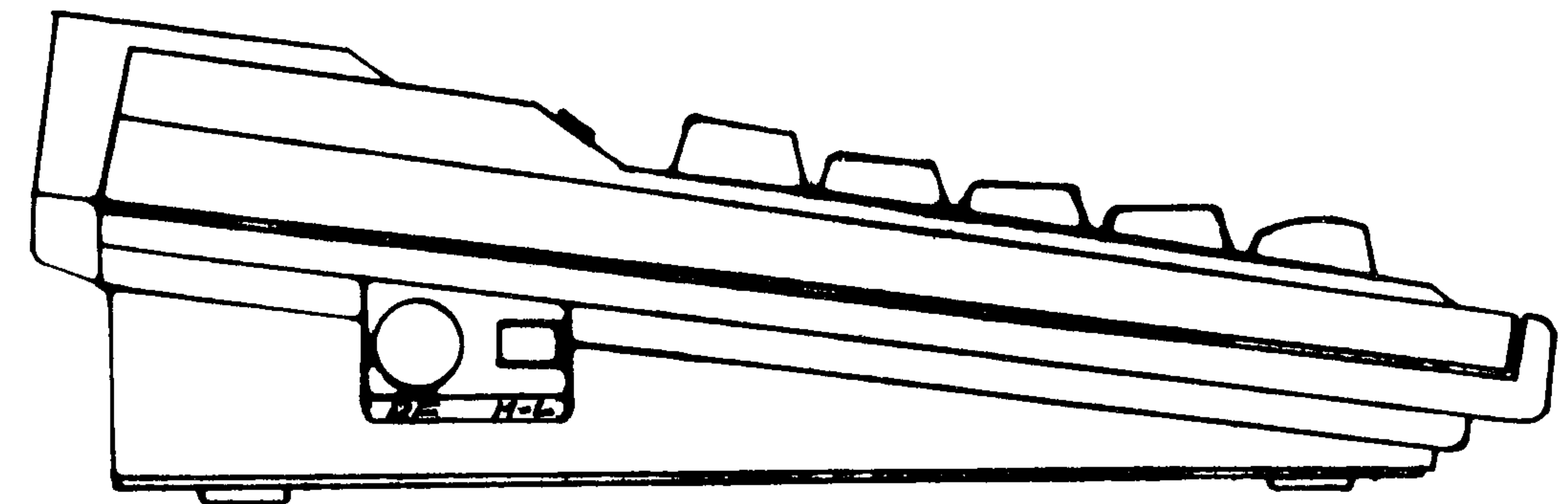
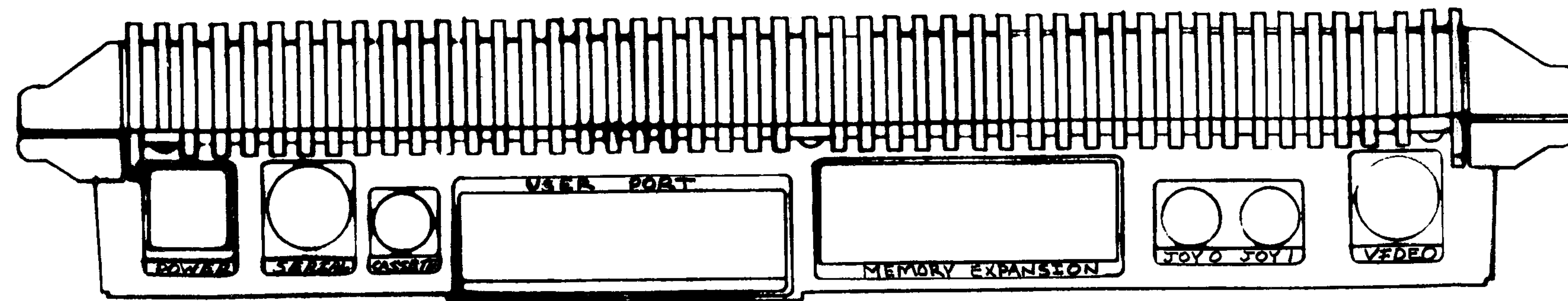
BOTTOM CASE ASSY

Bottom Case	C 251454-01
Foot, Self-Adhesive	C 950157-04
Paper Shield	C 310156-01
Shield Chip	C 310199-01
Shield Plate	C 310197-01
Insulation Sheet	C 310198-01

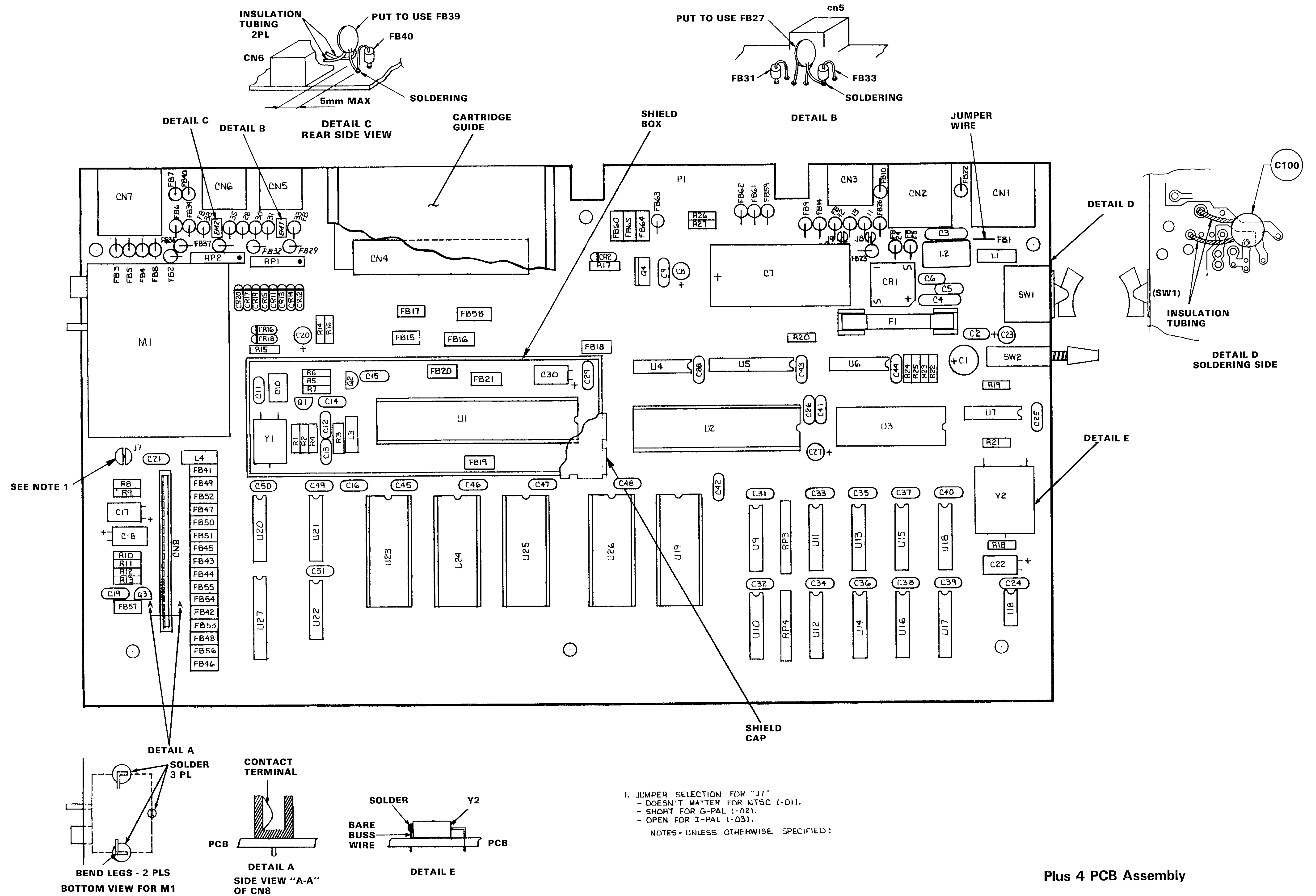
ACCESSORIES

Users Manual	C 310196-01
Power Supply	C 310157
RF Cable	C 326189-02
Switch Box	C 904778-01

C — Commodore Stock Part



Plus 4 Casework Identification



PARTS LIST — PLUS/4 PCB ASSEMBLY #310163-01

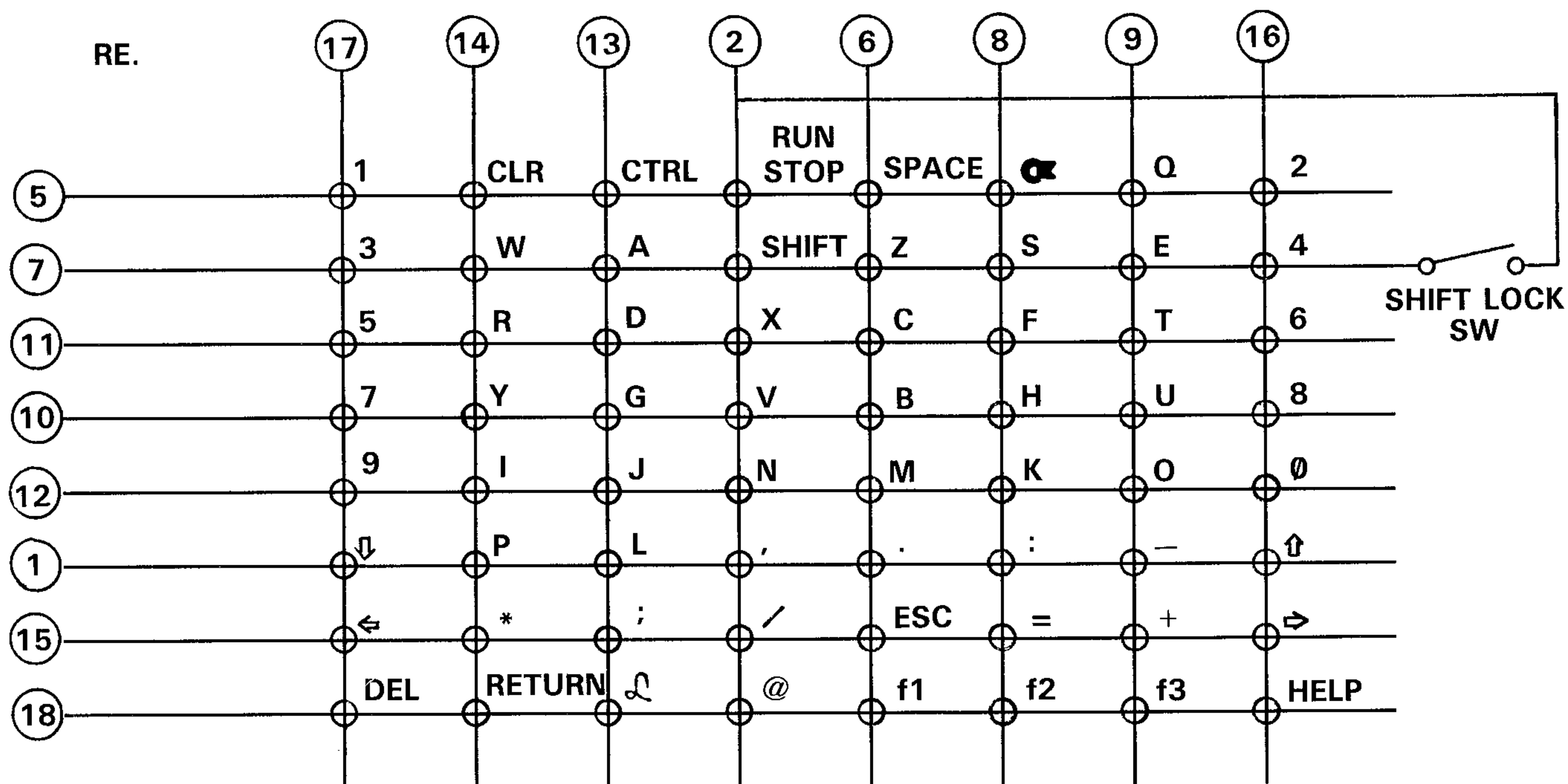
PLEASE NOTE: Commodore part numbers are provided for reference only and do not indicate the availability of parts from Commodore. Industry standard parts (Resistors, Capacitors, Connectors) should be secured locally. Approved cross-references for TTL chips, Transistors, etc. will be available in manual form through the Service Department in November of 1984. Unique or non-standard parts will be stocked by Commodore and are indicated on the parts list by a "C".

INTEGRATED CIRCUITS			DIODES (Continued)		
U1	7360 VLSI, Text Display (TED)		CR1	Bridge Rectifiers DBA20C	
	Sub: C 251535-01		(cont.)	Sanyo	251026-03
	8360 C 251535-02		CR2	Diode, Zener RD 6.8 EB	900927-01
U2	7501 Custom Microprocessor		CR11-20	Diode, IN 914 Sub:	900850-16
	C 251536-01			Diode, IN 4148 Taping	
U3	6551A (Synertek)	901895-02		251819-21 Sub:	
U4	74LS08	901521-03		Diode, IN 4148	900850-01
U5	6529B Single Port Interface		RESISTORS — All values are in ohms-1/4 W		
	C 251640-03		5% unless noted otherwise.		
U6	74LS04	901521-02	R1	4.7K	R14 240
U7	7406	901522-06	R2	10K	R15 250
U8	555	901523-01	R3	470K	R16 100K
U9-10	74LS257	901521-57	R4	220K	R17 1.5K
U11-18	4164-2 D-RAM	901505-01	R5	18K	R18 47K
U19	7700-010 PLA	C 251641-02	R6	1.5K	R19 100K
U20	74LS139	901521-18	R7	470K	R20 3K
U21	74LS175	901521-34	R8	100K	R21 1K
U22	74LS27	901521-22	R9	1K	R22 1K
U23	2312B ROM TED Basic		R10	1K	R23 1K
	C 318006-01		R11	12K	R24 1K
U24	23128 ROM TED Kernal		R12	10K	R25 1K
	C 318005-04		R13	1K	
U25	23128 FUNCTION ROM, 3+1 LOW		RESISTOR PACK		
	C 317053-01		RP1, 2	3.3K, 6 PIN	902441-29
U26	23128 FUNCTION ROM, 3+HIGH		RP3, 4	68, 8 PIN 4 ISOLATED	326149-06
	C 317054-01		CAPACITORS		
U27	6529B Single Port Interface		C1	Elect 0.1 μ F 25V	900100-40
	C 251640-03		C2	Ceramic 0.1 μ F 25V	251075-06
TRANSISTORS			C3	Film 0.22 μ F 100V	900150-11
Q1-Q3	2SC 1815	902693-01	C4	Film 0.22 μ F 100V	900150-11
Q4	2SD 880	902694-01 Sub:	C5-C6	Ceramic 0.22 μ F 50V	900022-01
	Tip 29A	902653-01 Sub:	C7	Elect 2200 μ F 16V	900101-33
	2SD 1266	902694-04	C8	Elect 10 μ F 16V	900100-25
DIODES			C9	Ceramic 0.1 μ F 25V	251075-06
CR1	Bridge Rectifiers S2VB10 Sindengen		C10	Trimmer 40 pF	251029-02
	215026-01 Sub:		C11	Ceramic 22 pF 50V	251070-14
	Bridge Rectifiers DBA20B Sanyo				
	251026-02 Sub:				

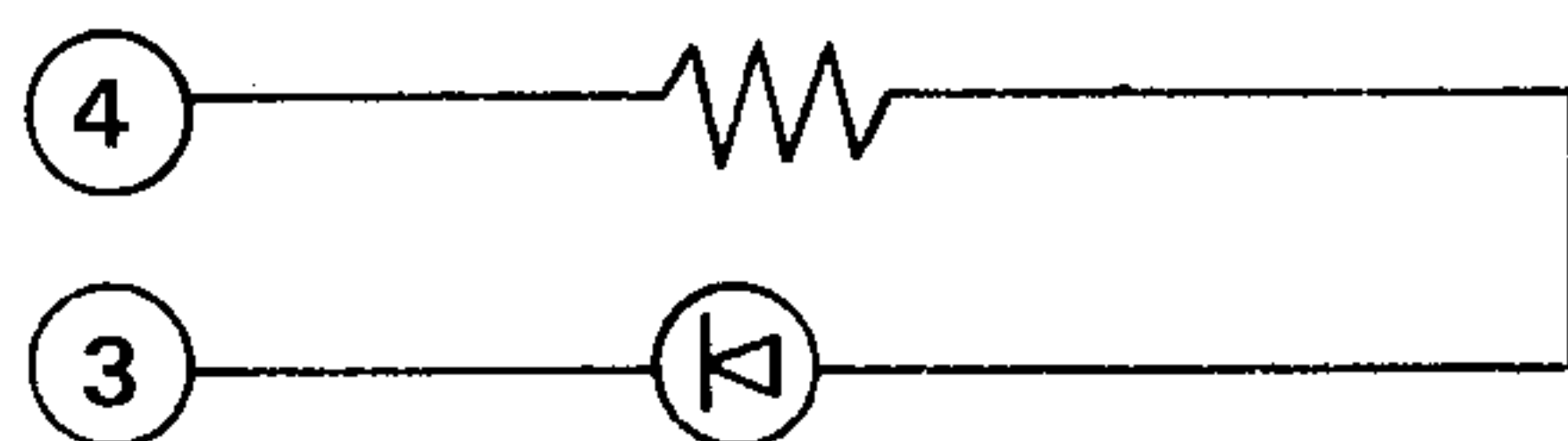
PARTS LIST — PLUS/4
PCB ASSEMBLY # 310163-01 (Continued)

CAPACITORS (Continued)				MISCELLANEOUS (Continued)		
C12	Ceramic	220 pF 50V	Sub: 251071-26 Sub:	FB2-14	Ferrite bead	325563-01
				FB15-21	Ferrite bead	903025-01
	Ceramic	220 pF 50V	900463-08	FB22-26,		
C13	Ceramic	150 pF 50V	251071-24	FB28-38,	Ferrite bead	325563-01
			Sub:	FB40		
	Ceramic	150 pF 50V	900462-41	FB41-58	Ferrite bead	903025-01
C14	Ceramic	0.1 μ F 25V	251075-01	FB59	Ferrite bead	325563-01
C15-C16	Ceramic	0.1 μ F 25V	251075-06	FB60	Ferrite bead	903025-01
C17-C18	Ceramic	10 μ F 16V	900100-25	FB61-63	Ferrite bead	325563-01
C19	Ceramic	0.01 μ F 25V	251075-01	FB64-65	Ferrite bead	903025-01
C20	Elect	10 μ F 16V	900100-25			
C21	Ceramic	0.1 μ F 25V	251075-06	EM1,2	EMI Filter	251842-01
C22	Elect	10 μ F 16V	900100-25			
C23	Elect	1 μ F 16V	900100-16	CN1	Connector 4 PIN (power supply)	
C24-C26	Ceramic	0.1 μ F 25V	251075-06			C 251614-01
C27	Elect	10 μ F 16V	900100-25	CN2	Connector 6 PIN DIN (serial bus)	
C28-C29	Ceramic	0.1 μ F 25V	251075-06			C 903361-01
C30	Elect	10 μ F 16V	900100-25	CN3	Connector 7 PIN MINI DIN (cassette)	
C31-C32	Ceramic	0.1 μ F 25V	251075-06			C 251616-01
C33-C40	Ceramic	0.22 μ F 25V	251075-07	CN4	Connector 50 PIN Female Edge (exoab)	C 251630-01
			Sub:	CN5-6	Connector 8 PIN MINI DIN (joy 1 & 2)	C 251259-01
	Ceramic	0.22 μ F 50V	900022-01			
C41-C51	Ceramic	0.1 μ F 50V	900020-06	CN7	Connector 8 PIN DIN (audio/video)	325573-01
			Sub:			
	Ceramic	0.1 μ F 50V	9000010-01	CN8	Connector 18 PIN (keyboard)	C 251841-01
C100	Ceramic	0.1 μ F 50V	900010-20			
MISCELLANEOUS						
Y1	Crystal	14.31818 MHZ	251081-01	L1	Noise Filter	251264-01
			Sub:	L2	Line Filter	906127-01
	Crystal	14.31818 MHZ	251081-02			251701-01
Y2	Crystal	1.8432 MHZ	900555-02			
				L3,L3	Coil Inductor 1.2 uHpt	901152-01
SW1	Switch, Rocker (PC Mount)		C 251587-01		Sub:	325570-01
SW2	Switch, Push Button		C 251260-01	F1	Fuse 250V 1.5A	903556-18
					Fuse Clip	906102-01
M1	RF Modulator		C 251844-01		Cartridge Guide	310171-01
					Shield Box	C 310172-01
	Sub:				Shield Cap	C 310173-01
	RF Modulator		251311-01			

C — Commodore Stock Part



KEYBOARD MATRIX



ϕ OIN	1	40	RES
RDY	2	39	R/W
IRQ	3	38	D0
AEC	4	37	D1
VCC	5	36	D2
A0	6	35	D3
A1	7	34	D4
A2	8	33	D5
A3	9	32	D6
A4	10	31	D7
A5	11	30	P0
A6	12	29	P1
A7	13	28	P2
A8	14	27	P3
A9	15	26	P4
A10	16	25	P5
A11	17	24	P6
A12	18	23	GATE IN
A13	19	22	A15
GND	20	21	A14

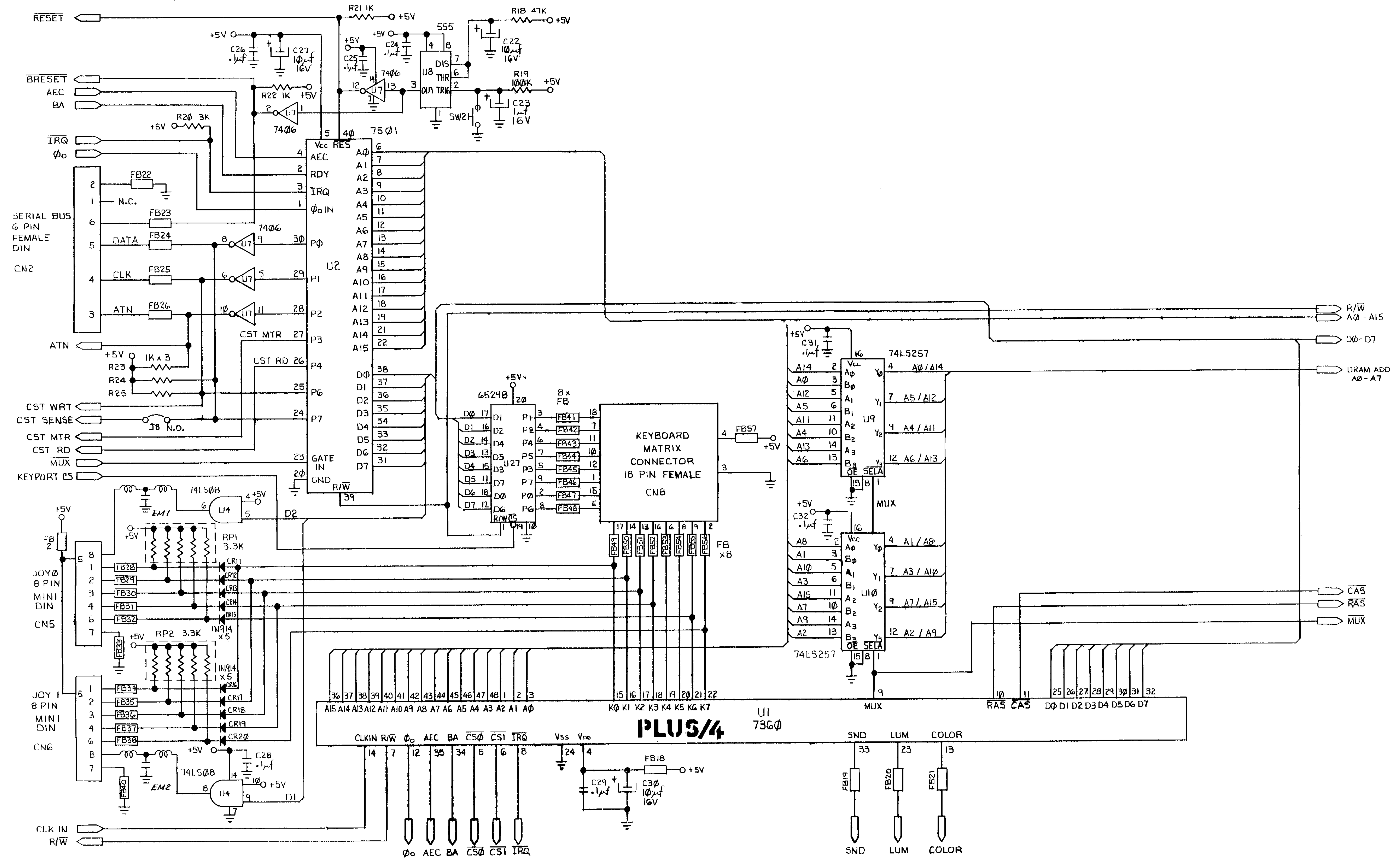
7501

PIN ASSIGNMENT
U2-251536-01
CUSTOM MICROPROCESSOR

A2	1	48	A3
A1	2	47	A4
A0	3	46	A5
VDD	4	45	A6
CS0	5	44	A7
CS1	6	43	A8
R/W	7	42	A9
IRQ	8	41	A10
MUX	9	40	A11
RAS	10	39	A12
CAS	11	38	A13
ϕ 0	12	37	A14
COLOR	13	36	A15
CLK IN	14	35	AEC
K0	15	34	BA
K1	16	33	SND
K2	17	32	D7
K3	18	31	D6
K4	19	30	D5
K5	20	29	D4
K6	21	28	D3
K7	22	27	D2
SYNC	23	26	D1
VSS	24	25	D0

7360

PIN ASSIGNMENT
U1-251535-01
VLSI, TEXT DISPLAY
(TED)



Plus 4 Schematic #310164 (1 of 4)

M₁ SCHEMATIC ON PAGE 11

PIN
CONFIGURATION

VSS	1	28	R/W
CS0	2	27	Q2
CS1	3	26	IRQ
RES	4	25	D7
RXC	5	24	D6
XTL1	6	23	D5
XTL0	7	22	D4
RTS	8	21	D3
CTS	9	20	D2
TXD	10	19	D1
DTR	11	18	D0
RXD	12	17	DSR
RS0	13	16	DCD
RS1	14	15	VCC

6551

U3-901895-02
ACIA

SYNERTEK	SYP6551A	2 MHZ
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PIN
CONFIGURATION

FE	1	28	VCC
I7	2	27	I8
I6	3	26	I9
I5	4	25	I10
I4	5	24	I11
I3	6	23	I12
I2	7	22	I13
I1	8	21	I14
I0	9	20	I15
F7	10	19	CE
F6	11	18	F0
F5	12	17	F1
F4	13	16	F2
GND	14	15	F3

U19-251641-02
PLA

TRANSMIT/RECIEVE CHARACTERISTICS

CHARACTERISTICS	SYM	-02 2 MHZ		UNIT
		MIN	MAX	
TRANSMIT/RECEIVE CLOCK RATE	t _{CCY}	*	400	ns
TRANSMIT/RECEIVE CLOCK HIGH TIME	t _{CH}	175	—	ns
TRANSMIT/RECEIVE CLOCK LOW TIME	t _{CL}	175	—	ns
XTL1 TO TXD PROPAGATION DELAY	t _{DD}	—	500	ns
RTS PROPAGATION DELAY	t _{DLY}	—	500	ns
IRQ PROPAGATION DELAY (CLEAR)	t _{IRQ}	—	500	ns

(tr, tf = 10 to 30 ns)

*The Baud Rate with External Clocking is:

BAUD RATE $\frac{1}{16 \times T_{CCY}}$

PIN
CONFIGURATION

CS	R/W	D0-D7
L	L	DATA BUS TO PORT
L	H	PORT TO DATA BUS
H	X	ISOLATION

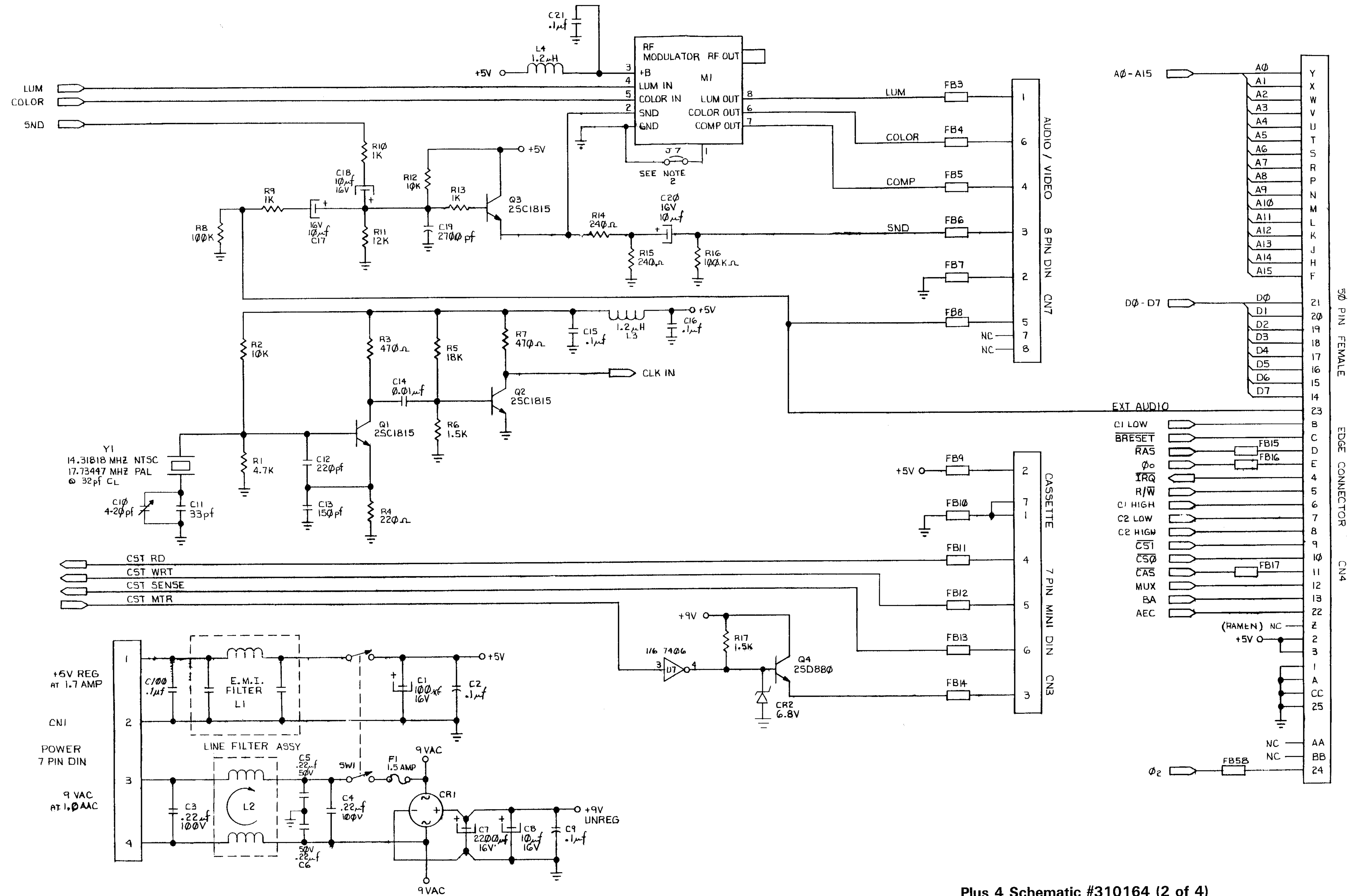
L = LOW LEVEL
H = HIGH LEVEL
X = IRREVELANT

R/W	1	20	VDD
P0	2	19	CS
P1	3	18	DB0
P2	4	17	DB1
P3	5	16	DB2
P4	6	15	DB3
P5	7	14	DB4
P6	8	13	DB5
P7	9	12	DB6
VSS	10	11	DB7

6529

MOS	6529B	3 MHz
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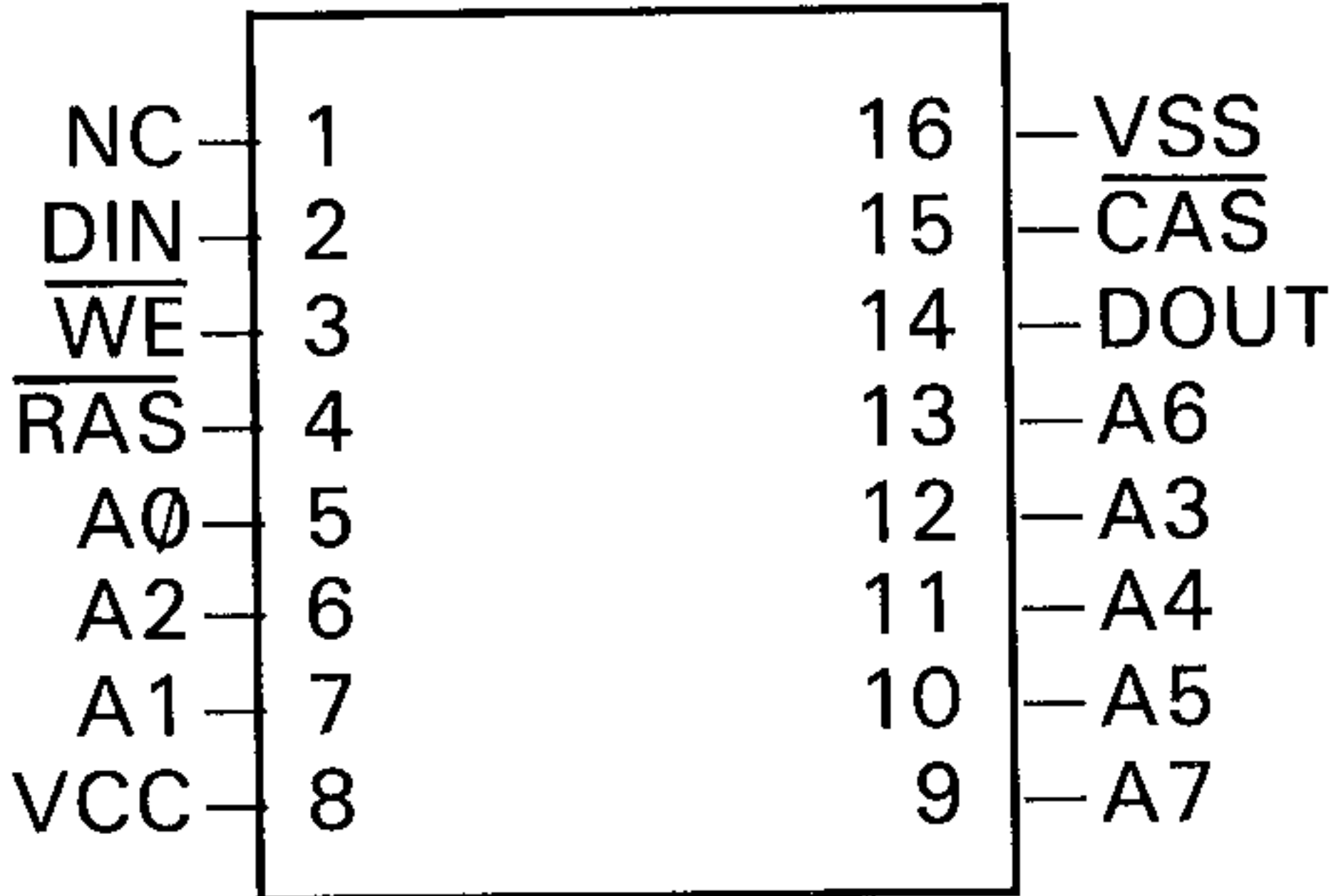
U5/U27-251640-03
SINGLE PORT
INTERFACE



Plus 4 Schematic #310164 (2 of 4)

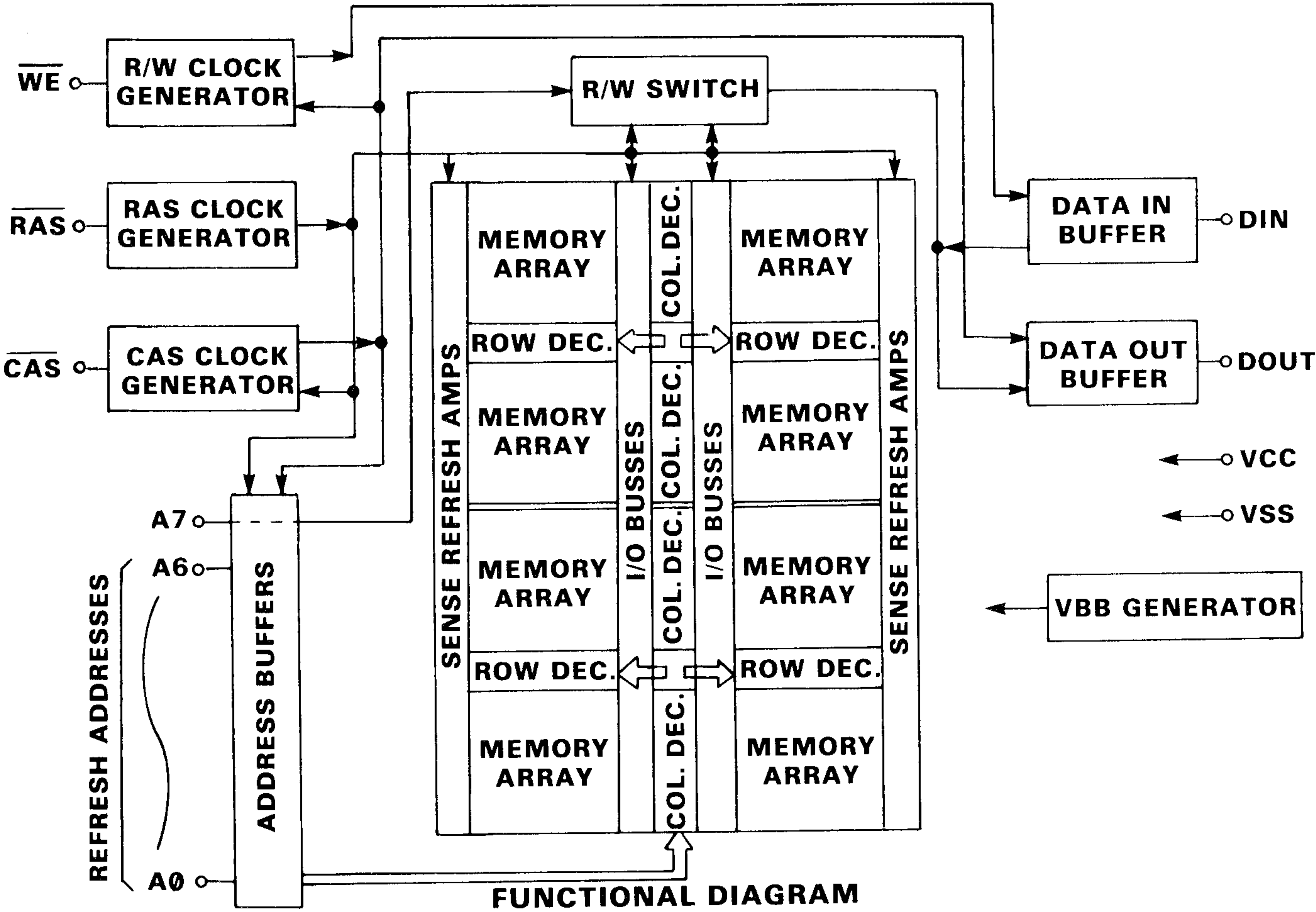
U3, U5, U19 PINOUTS ON PAGE 8

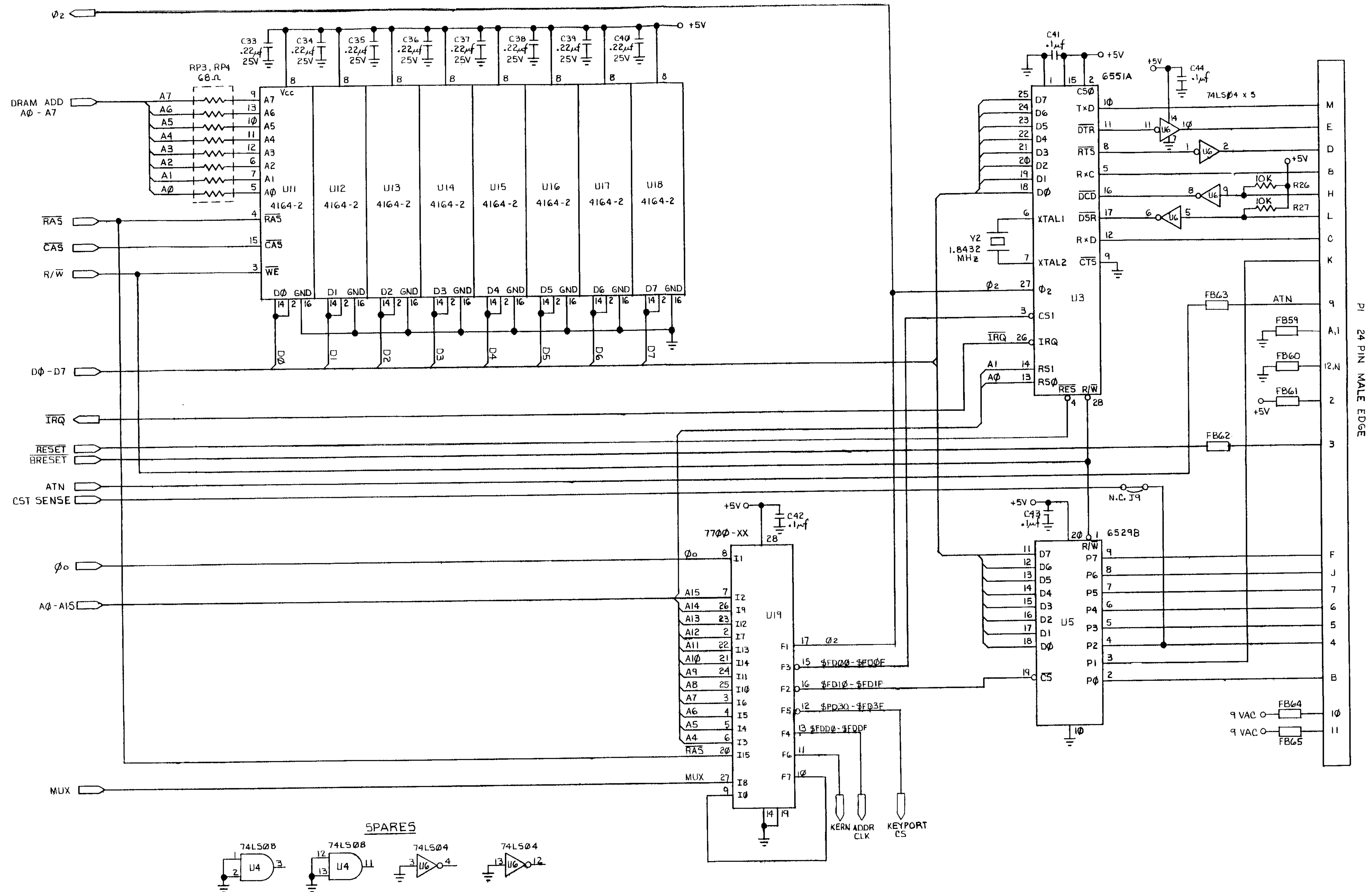
PIN CONFIGURATION



U11 ~ 18
64K DYNAMIC RAM
901505-01

COMMODORE PART NUMBER	APPROVED SOURCE 1 OF SUPPLY	VENDOR PART NUMBER	ACCESS TIME (ns)	CYCLES (ns)	POWER	
					ACTIVE (MW)	STANDBY (MAX)(MW)
901505-01	HITACHI	HM4864-3	200	335	330	20
901505-01	NEC	μPD4164-2	200	375	250	28
901505-01	MITSUBISHI	M5K416NS-20	200	330	275	28
901505-01	MOSTEK	MK4564N-20	200	345	300	22
901505-01	OKI	MSM3764-20	200	330	248	23
901505-01	HITACHI	HM4864P-3	200	335	330	20
901505-01	MATSUSHITA (PANASONIC)	MN4164P-20	200	330	275	27.5
901505-01	SIEMENS	HYB4164-3	200	330	150	20
901505-01	SHARP	LH2164-Z1	200	330	248	28
901505-01	HITACHI	HM4864AP-3	200	330	242	20
901505-01	TOSHIBA	TMM4164AP-20	200	330	275	22





Plus 4 Schematic #310164 (3 of 4)

PIN CONFIGURATION

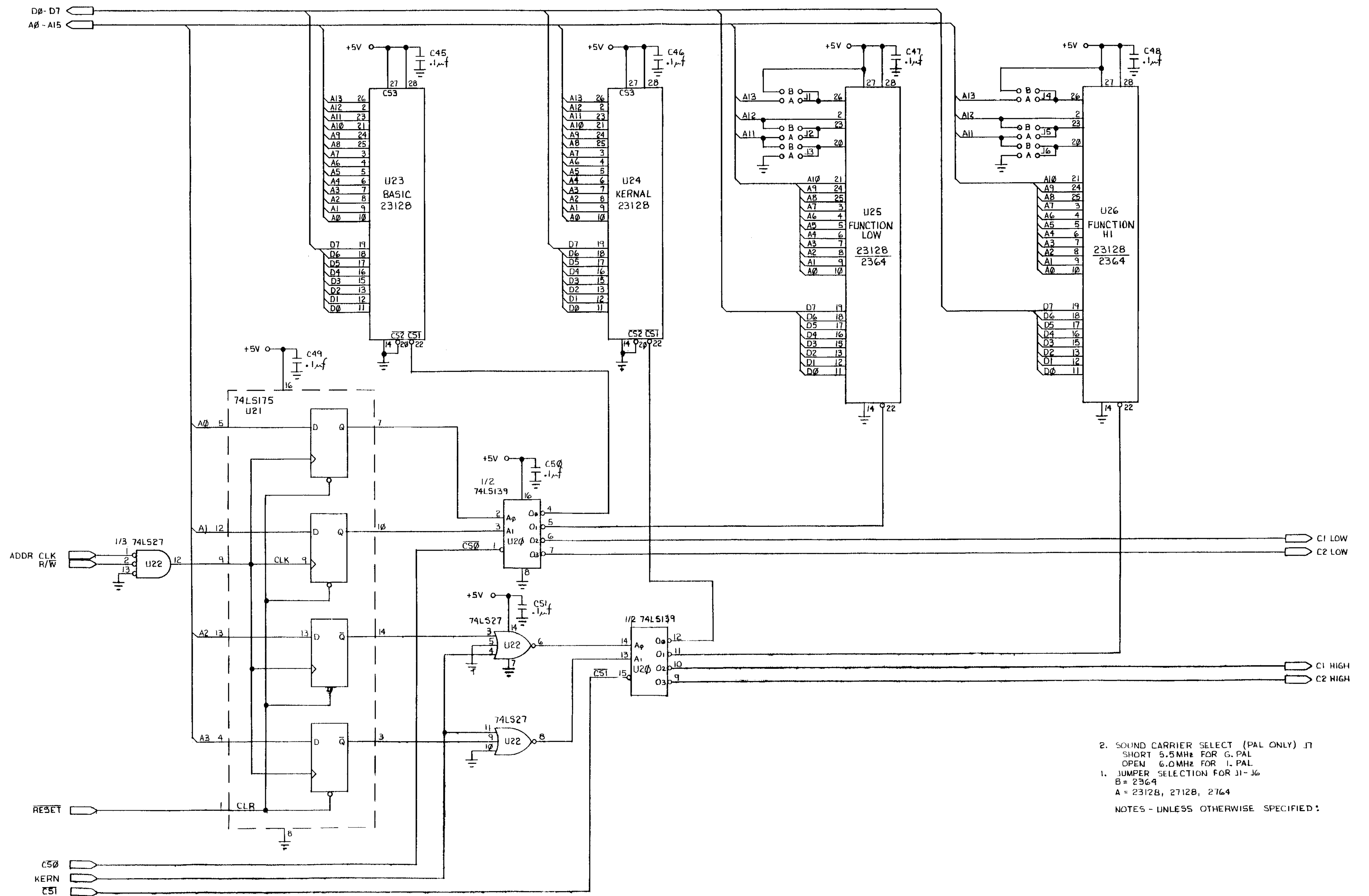
NC	1	28	VCC
A12	2	27	CS ₃
A7	3	26	A13
A6	4	25	A8
A5	5	24	A9
A4	6	23	A11
A3	7	22	CS ₁
A2	8	21	A10
A1	9	20	CS ₂
A0	10	19	D8
D1	11	18	D7
D2	12	17	D6
D3	13	16	D5
GND	14	15	D4

U23-318006-01
ROM — BASIC

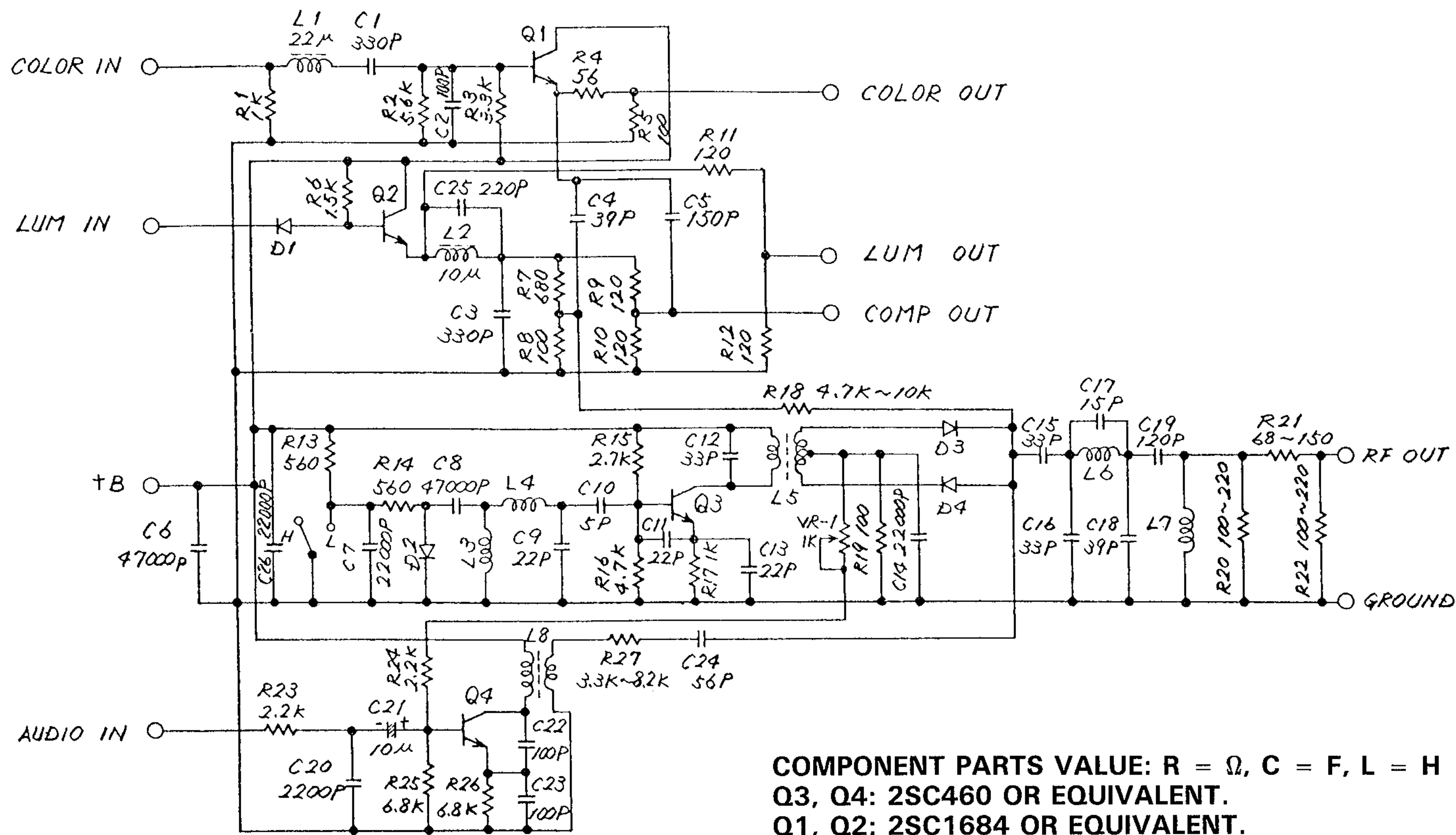
PIN CONFIGURATION

NC	1	28	VCC
A12	2	27	CS ₃
A7	3	26	A13
A6	4	25	A8
A5	5	24	A9
A4	6	23	A11
A3	7	22	CS ₁
A2	8	21	A10
A1	9	20	CS ₂
A0	10	19	D8
D1	11	18	D7
D2	12	17	D6
D3	13	16	D5
GND	14	15	D4

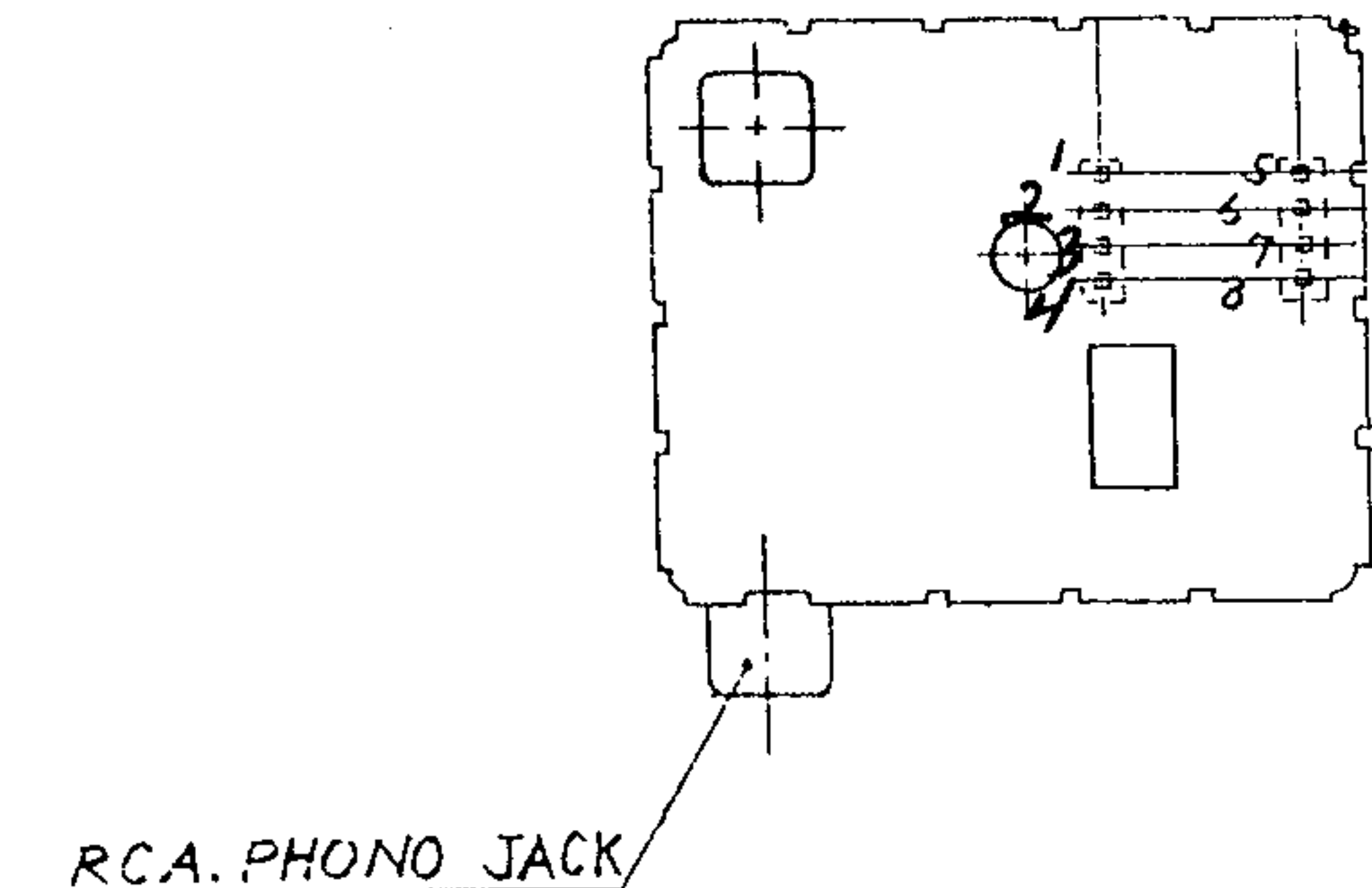
U24-318005-04
ROM — KERNAL



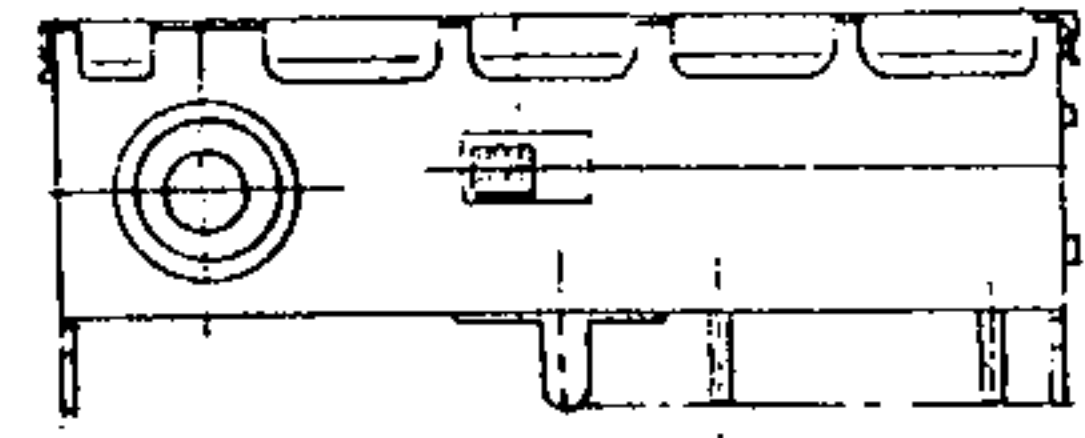
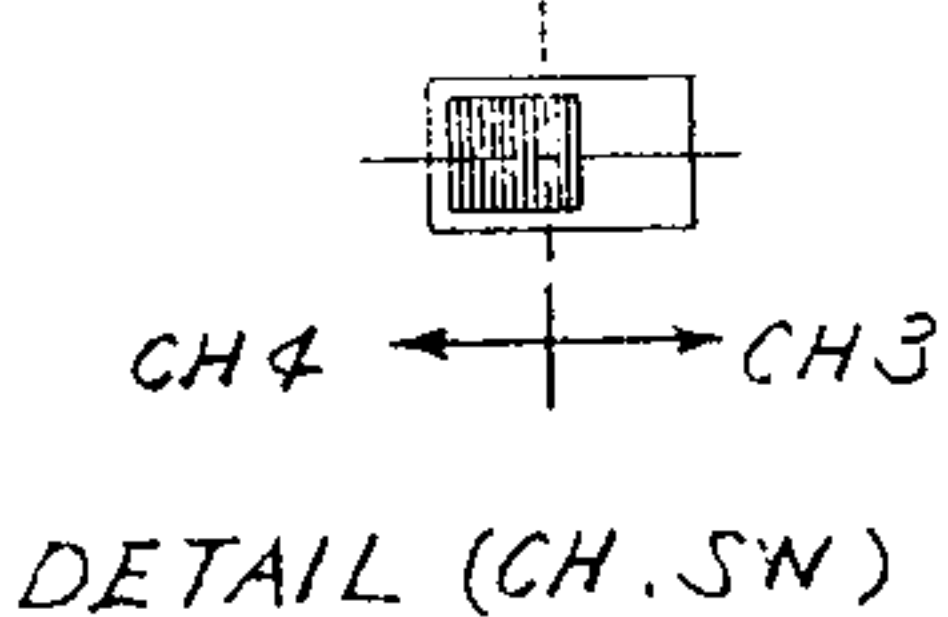
Plus 4 Schematic #310164 (4 of 4)



COMPONENT PARTS VALUE: R = Ω , C = F, L = H
Q3, Q4: 2SC460 OR EQUIVALENT.
Q1, Q2: 2SC1684 OR EQUIVALENT.
D3, D4: 1SS198 OR EQUIVALENT.
D2 : 1SS110 OR EQUIVALENT.
D1 : 1SS119 OR EQUIVALENT.

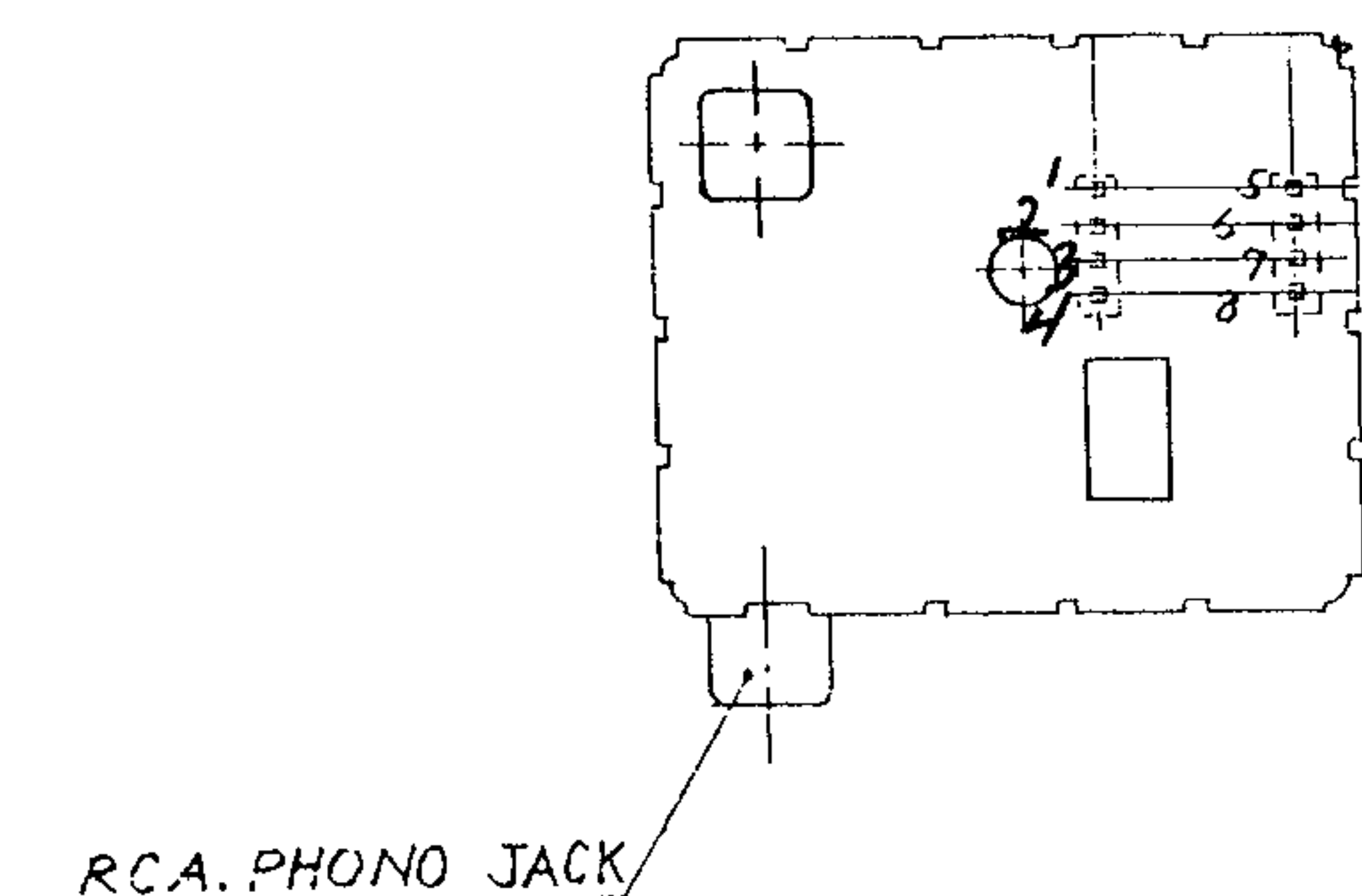
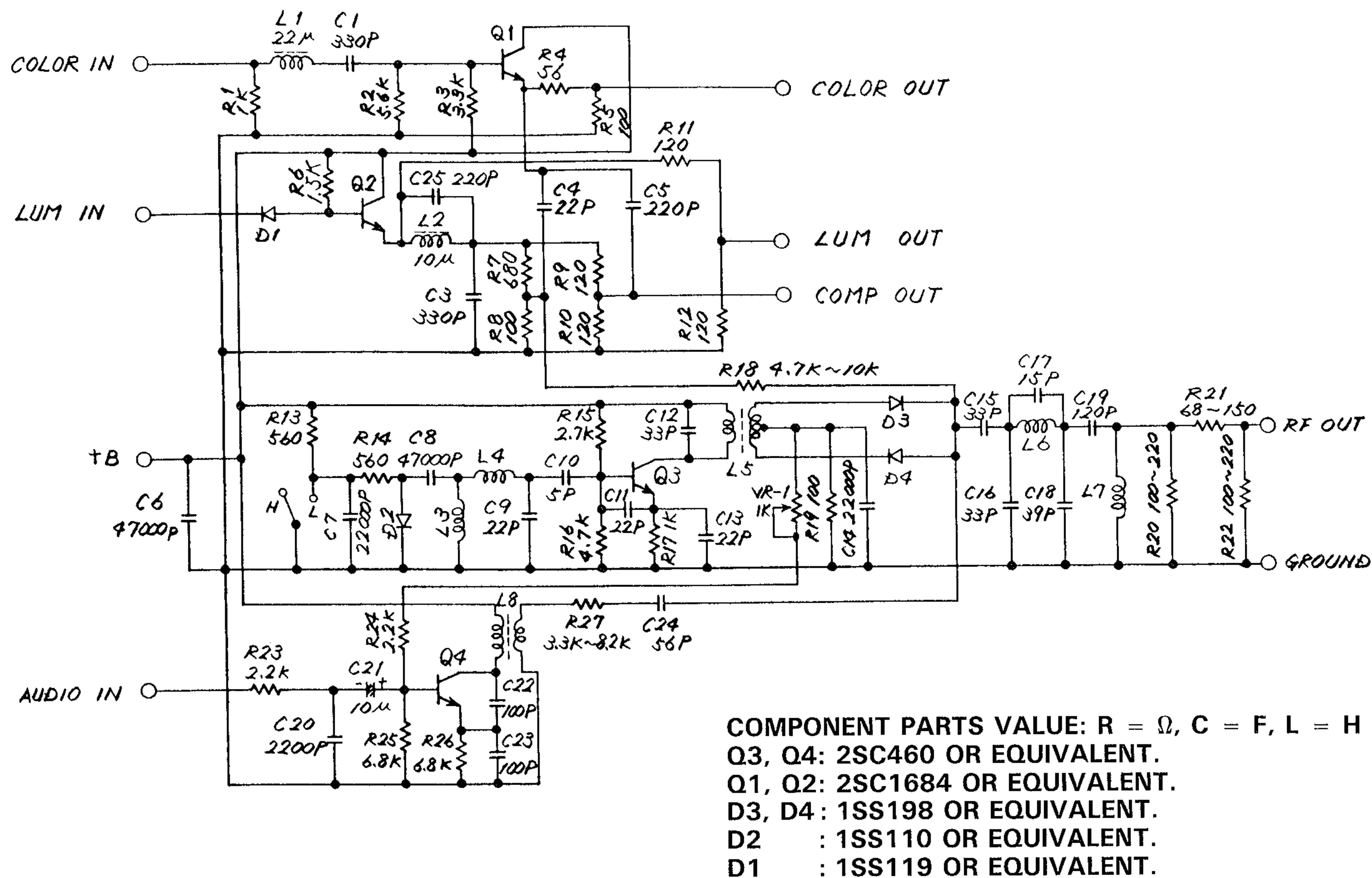


TOP VIEW

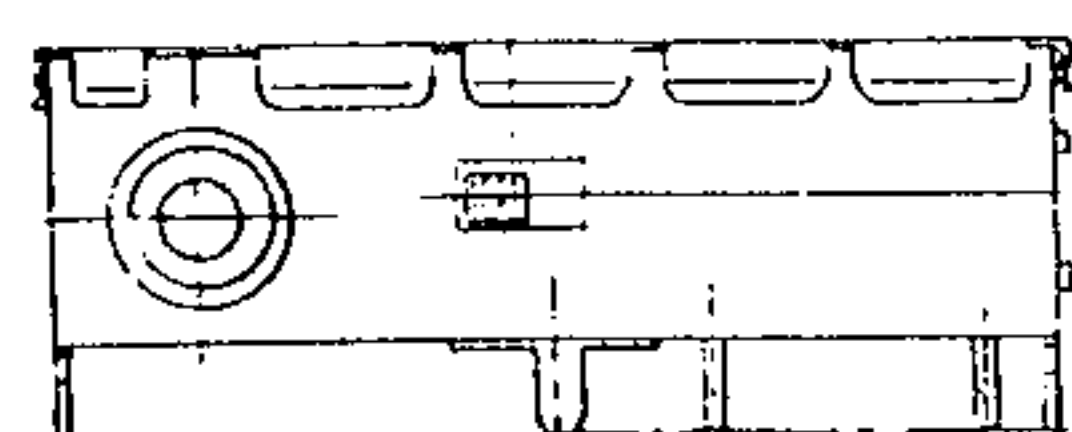


REAR VIEW

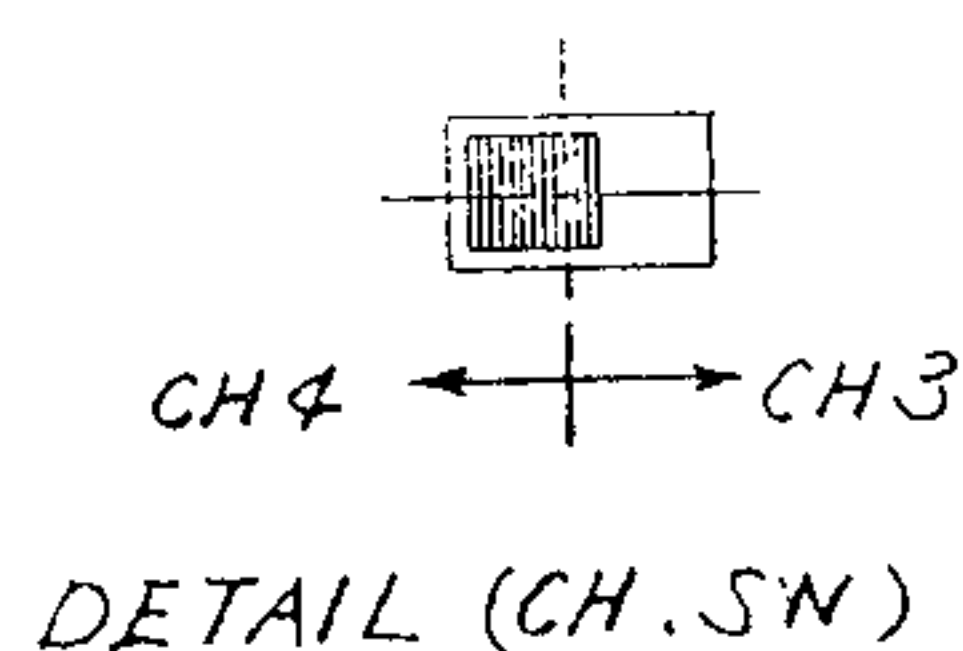
NO.	TERMINALS
1	N.C.
2	AUDIO SIG. INPUT
3	+B (+5V)
4	SYNC + LUM. SIG. INPUT
5	COLOR SIG. INPUT
6	COLOR SIG. OUTPUT
7	COMPO. SIG. OUTPUT
8	SYNC + LUM. SIG. OUTPUT
9	RF OUTPUT
10	CHANNEL SELECT SW.



TOP VIEW



REAR VIEW



NO.	TERMINALS
1	N.C.
2	AUDIO SIG. INPUT
3	+B (+5V)
4	SYNC + LUM. SIG. INPUT
5	COLOR SIG. INPUT
6	COLOR SIG. OUTPUT
7	COMPO. SIG. OUTPUT
8	SYNC + LUM. SIG. OUTPUT
9	RF OUTPUT
10	CHANNEL SELECT SW.

Troubleshooting Aides

Areas of the PCB particularly vulnerable to this problem are:

1) NO VIDEO - Absolutely no video on screen

O.K. If not:

- 1) Check fuse
- 2) Check for twisted or bent caps
(5 V. short to ground)
- 3) Check L1

O.K.

If not:

- 1) Check for good connection at pin 14 of U1
- 2) Check for good connection at R1 thru R7

O.K. If not: 1) Check for LUM signal shorted to ground
↓ 2) Check for open traces
 3) Check modulator

↓
E) Check for control signals:

Signal	I.C.	Pin	Signal	I.C.	Pin
AEC	U1	35	R/W	U1	7
AEC	U2	4	0	U1	12
CAS	U1	11	MUX	U1	9
CS1	U1	6	IRQ	U1	8
CS1	U20	15	RDY	U2	2
CS0	U1	5	BA	U1	34
CS0	U20	1	RAS	U1	10

2) BAD VIDEO - Scrolling lines on screen - Random blocks on screen - Blurred display

- A) Check J1-J6 for shorts to ground or each other
O.K.
↓
- B) Check reset for correct operation
O.K.
↓
- C) Check U1 for proper operation
O.K. If not: 1) Check socket for good solder
↓ 2) Check for bad U1
- D) Check U2 for proper operation
O.K. If not: 1) Check socket
↓ 2) Check for bad U2
- E) Check RAM data lines for correct amplitude
O.K. If not: 1) Check for hot surface of RAM
↓ 2) Jump out RAM to verify
- F) Check multiplexers U9, U10 - signals at RP3
and RP4 should be similar in frequency and
amplitude
O.K. If not: 1) Suspect U9 or U10
↓
- G) Check ROM for chip select signal at pin 22 of
U23 and U24
O.K. If not: 1) Check for signal generation
↓ at U20
- H) Check that all ROM addresses are present and
correct amplitude
O.K. If not: 1) Trace problem address A0-A15
↓
- I) Check U19, U23, U24 by replacement with known
good

3) NO POWER

- A) Verify voltage +5 and +9 volts
 - 1) Check for shorts to ground
 - 2) Check switch
 - 3) Check power supply

4) BAD BASIC - Random characters on screen - Random colors - Power-up message is missing

- A) Check Basic ROM U23
- B) Check B thru I above (Bad Video)

5) NO COLOR or BAD COLOR

- A) Check U1 pin 14 for 14.31818 MHz with frequency counter
O.K. If not: 1) Check solder joints of CT1
↓ and adjust for correct frequency
2) Check crystal, Q1 and Q2
3) Check clock circuit for opens or shorts
- B) Check U1 pin 13 for Color Out signal.
O.K. If not: 1) Swap U1 w/known good
↓
- C) Check modulator M1 pin 5 for Color In signal and pin 6 for Color Out signal
O.K. If not: 1) Check M1 operation
↓
- D) Check FB4 and CN7 pin 6 to see if color signal is present.
1) Check for shorts

6) NO SOUND or BAD SOUND

- A) Check U1 pin 33 for SND signal
O.K. If not: 1) Check socket for open circuit
↓ 2) Swap U1 w/known good
- B) Check audio circuit for short to ground or loss of signal.
O.K. If not: 1) Check Q3 - Be sure emitter and base are not shorted to 5 V.
↓
- C) Check modulator M1 pin 2 for SND signal
1) Adjust I.F. can (top right of modulator) for clean, loud volume
2) M1 pin 2 to ground should read approximately 480 ohms
3) Check M1 for component failure

7) SERIAL FAILURES

- A) Check FB23-26 for shorts to shield or each other
B) Check U7, U2 and CN2

A) Check pins on ribbon cable for good connection
O.K.

To Check: 1) Press 'F1' on keyboard

4) Type 'tc' and press 'Return' to enter Spreadsheet

6) Type 'tw' to return to Word Processing mode

A) Check jumpers at J1-J6 for correct connection
O.K.

→

B) Check U1, U2, U25, U26

Model: C16, PLUS 4

LINE DEFINITIONS

A0 to A15	Address Bit 0 to 15
AEC	Address Enable Control
ATN	Attention
BA	Bus Available
BRESET	Buffered System Reset
C1 HIGH, C1 LOW	External Cartridge Chip Select
C2 HIGH, C2 LOW	"
CAS	Dynamic RAM Column Address Strobe
CLK IN	Master Clock (Single Phase, 14.31818 MHz)
COLOR	Chroma Output
COMP	Composite Chroma and Luma
CE	Chip Enable
CS	Chip Select
CS0	Low ROM Chip Select
CS1	High ROM Chip Select
CST MTR	Cassette Motor Control
CST RD	Cassette Read
CST SENSE	Cassette Sensor
CST WRT	Cassette Write
CTS	Clear To Send
DB0 to DB7	Data Bit 0 to 7
DCD	Data Carrier Detect
DRAM	Dynamic RAM
DRAM ADD	Dynamic RAM Address
DSR	Data Set Ready
DTR	Data Terminal Ready
EXT AUDIO	External Audio Input
GATE IN	R/W GATE
IRQ	Interrupt Request
K0 to K7	Keyboard Latch 0 to 7
KERN	Kernal ROM Control Line
LUM	Composite Sync and Luminance
MUX	Address Multiplex Control
P0 to P7	Port Bit 0 to 7
RAS	Dynamic RAM Row Address Strobe
RESET	System Reset
RxC	Receive Clock
RxD	Receive Data
R/W	Read/Write Line
RTS	Request To Send
SND	Sound Line
TED	Text Display
TxD	Transmit Data
⌀ 0	System Clock (Varies between 1 and 2 MHz)
⌀ 2	Artificial ⌀ 2, Address Valid Rising Edge, Data Valid Falling Edge

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commodore TECHTOPICS

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SCHEMATICS FOR C-64, C-16, PLUS 4

These computers have been affected by an Engineering Change Order that adds 4 diodes to the serial port. These protection diodes are not required as field upgrades. They are 1N914s and were added as a circuit improvement.

The Schematic and PCB Layout for the C-64 in the Service Manual (Pages 28 and 32) include these diodes. However, the C-16 and Plus 4 Service Manuals were completed before the changes were made. The Schematic corrections are shown below:

